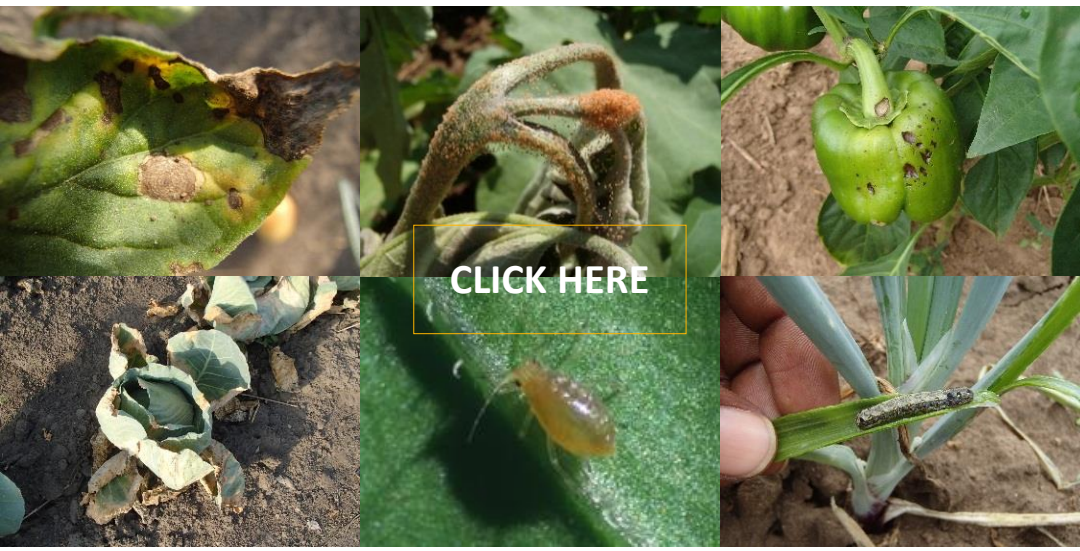
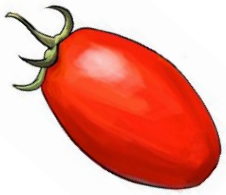
NUFLIP
NORTHERN UGANDA FARMERS' LIVELIHOOD IMPROVEMENT PROJECT

Factsheet on vegetable pests, diseases, and physiological disorders

those found in the NUFLIP demonstration fields
In Acholi sub-region



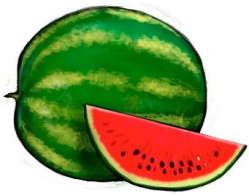
Factsheet on vegetable pests, diseases, and physiological disorders



Pests | Diseases

Pests | Diseases

Pests | Diseases



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Field crickets
[*Gryllus* spp.]

Cut hypocotyl

Damage at the growing point

Damage on cotyledons

Host plants	Tomatoes, eggplants, green peppers, watermelons, etc.
Damages	Feeds and cuts off sprouts and young plants.
Other features	Hide in hidden tunnels and damage the plant roots.
Control	Spray insecticides on the nursery bed as a repellent. Mancozeb fungicide has repellent effects. Protect the nursery bed with an insect net or boxed frame of more than 20 cm in height.

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Variegated grasshopper [*Zonocerus variegatus*]

Feeds on many kinds of vegetables with a voracious appetite.

Nymphs aggregated on eggplants

Host plants	A wide range of plants
Damages	**Feeds on the leaves and stems** of both young and matured plants with a voracious appetite.
Other features	Feeds on crops in aggregation during larger instar stages.
Control	Insecticide should be sprayed in the early morning before the air temperature rises in consideration of the insect's habits of activity. Spray on both the crops and surrounding field.

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Thrips
[*Thrips tabaci, Thrips palmi*]

Damage on the tomato leaf surface (left) and the back (right)

Damage on the flower

Thrips on the tomato fruit

Moderate damage on the tomato fruit

Severe damage on the tomato fruit

Host plants	Eggplants, green peppers, onions, watermelons, onion, tomato, etc.
Damages	The damage varies with host plants and species. **White dots** or a **splashed pattern** generally appear on the surfaces of young leaves or fruits. Flower parasitism and fruit malformation are also observed.
Other features	The insect population increases in high temperature and in light rain.
Control	Spray insecticide a few times at 7- to 10-day intervals. Light reflection can paralyze the insect.

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Aphids
[Aphis spp., *Aulacorthum* spp., *Myzus* spp.]

Colony on the back of a leaf

Viral diseases transmitted by aphids

Lady bugs are a major natural enemy. Adult (left) and Larva (right)

Host plants	Green peppers, eggplants, watermelons, onions, etc.
Damages	**Sucks sap** from plant tissue. The leaves are stunted, distorted, and often curled under. Surfaces become sticky and tainted by black mold. Aphids also transmit CMV, PepMov, and other **viral diseases**.
Other features	Has a **symbiotic relationship with ants.** Aphids should be suspected once ants are found on the plants.
Control	Spray insecticides with rotation. Plant sorghums or corns around the field as a barrier and cultivate natural enemies.

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Spider mites
[Tetranychus spp.]

Damage on the surface (left) and back side (right) of the eggplant leaf

Colony

Damage on the surface (left) and back side (right) of the tomato leaf

Nets produced by the mites

Host plants	A wide range of plants
Damages	**Sucks sap** from the plant tissue. The damage first appears on the leaves as a **stippling of light dots.** The color then turns **bronze, yellowish,** or **reddish** until the leaf finally drops off.
Other features	The insects are mostly found on the backs of leaves and prefer **hot and dry** conditions.
Control	Spray insecticides. A spray of even water alone can reduce the population. Predatory mites are the most effective natural enemy.

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Rust (Russet) mites [*Aculop* ssp.]

The stems of the tomato turn bronze due to rust mites. The insect is too tiny to easily detect with the naked eye

Host plants	Mainly Solanaceae vegetables, especially tomatoes
Damages	**Sucks sap**. The infection starts from the **lower part** of the leaf or stem. The infested part turns **bronze**. The insect spreads over the whole body and finally kills the plant.
Other features	Because of **their tiny size**, these mites are rarely noticed until the plants are damaged. The insect prefers **mild temperatures** (around 25-27°C) and dry conditions.
Control	Early detection and quick measures are important. Immediately spray pesticides several times with rotation.

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Leaf-footed bugs
[*Leptoglossus* spp.]

An adult sucking sap from the eggplant. The plant stem withers from the infested part

A nymph on a leaf

Host plants	Eggplants, tomatoes, onions, Cucurbit vegetables, etc.
Damages	**Sucks sap** from the plant tissue. Wilting of growing points, delayed maturation of young fruits, and discoloration of matured fruits are observed. Insects of the Coreidae family are generically called “leaf-footed bugs.”
Other features	The insects migrate as a group from the bush when the fruits start developing.
Control	I**nsecticide should be sprayed in the early morning** before the air temperature rises in consideration of the insect’s habits of activity.

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Eggplant lace bugs
[*Urentius hystricellus*]

The nymph is spiny.

The damaged leaves of eggplant in the nursery

Host plants	Eggplants, tomatoes, onions, cucurbit vegetables, etc.
Damages	The leaves develop **yellow patches,** turn wavy, and are soiled with excreta. Damage often becomes severe in the nursery.
Other features	Nymphs and adults are found on the surfaces of the leaves. The adults are yellowish brown, flat, and lace-like, and the nymphs are spiny. Populations increase during hot and dry conditions.
Control	Spray systemic insecticides in the nursery.

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Ladybird beetles
[*Epilachna* spp.]

An adult feeding on a tomato leaf.

Step-like feeding marks are found on damaged leaves.

Host plants	Eggplants, potatoes, tomatoes in the Solanaceae family.
Damages	**Adult and larvae feed on the backs of leaves**. Step-like feeding marks appear on the damaged leaves.
Other features	Though herbivorous, ladybird beetles of this genus are close to the predatory ladybird beetles popularly exploited as a natural enemy of aphids. The elytra are covered with fine hairs and are lusterless. The predatory ones are lustrous.
Control	This insect is susceptible to insecticides.

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Blister beetles
[*Epicauta* spp.]

Adults feeding on eggplant flowers and leaves

Host plants	Eggplants, potatoes, groundnuts, soybeans, carrots, etc.
Damages	**The adults feed on flowers and leaves**, and sometime fruits, as well. They have a voracious appetite.
Other features	These beetles **tend to aggregate and feed in swarms.** The swarms can appear suddenly. They prefer hot and dry conditions. The larvae are predatory and feed on the eggs of grasshoppers or other small insects. Insects of the Meloidae family are generically called “blister beetles.”
Control	This insect is susceptible to insecticides.

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Gall midges
[Family Cecidomyiidae]

Puff galls developing on infested parts of the plant

Puff gall and larva growing in the center chamber

Host plants	Solanaceae plants
Damages	**Puff galls** with long trichomes develop on leaves, stems, or flowers. The galled part of the leaf is greatly thickened. Infested parts show stunted or malformed growth.
Other features	Several species develop the galls. The adults are tiny and hard to detect. They lay eggs in the tissue of the plant and develop galls. **The larvae grow in the central chamber of the gall.**
Control	Spray systemic insecticides preventively. The galls should be removed and destroyed.

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Leaf minors
[*Liriomyza* spp.]

Feeding damage by larvae on tomato leaves.

Feeding damage by larvae on eggplant leaves

Host plants	A wide range of plants
Damages	**The adult maggots suck sap** from the leaves, leaving tiny white spots on the leaf surfaces. The larvae injure the tissue as they travel across the leaves, leaving white streaky feed damage marks. In severe cases the leaves turn white, then brown, and fall off, suppressing the growth of the plant.
Other features	Many natural enemies exist in the field. Parasitized larvae turn brown.
Control	Spray systemic insecticides a few times at 7-day intervals.

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Bollworms
[*Helicoverpa* spp.]

Larvae feeding on the insides of immature tomato fruits

Young larvae feeding on soft leaves or flowers. Black droppings are found on the upper leaves.

Host plants	Solanaceae vegetables, maizes, cottons, etc.
Damage	**Feeds on young leaves, flowers, and the insides of immature fruits**
Other features	The adult lays eggs on young leaves individually. The young larvae feed on soft leaves near growing points and then bore into the fruits.
Control	Spray insecticides once you find the small black droppings of larvae on the leaves just below the growing point. Protect the field by tall barrier plants to prevent the adults from migrating from the bush.

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Armyworms
[*Spodoptera* spp.]

Larvae on tomato (left) and eggplant (right) leaf

Egg-mass covered with hairs on cabbage

Host plants	Many crops, including vegetables and weeds
Damages	The larvae feed on leaves and penetrate into the plants. Young seedlings are cut down.
Other features	The eggs are laid in masses. The hatched larvae feed on leaves in groups and **gradually disperse to surrounding areas.**
Control	Insecticide control is effective for the young larvae but not for matured ones.

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Root-knot nematodes [*Meloidogyne* spp.]

Root-knot on tomato caused by nematodes

Host plants	Wide range
Damages	The infested plant shows **stunted growth** and swollen "**knots**" on the roots. Affected plants are more easily infected by soil-borne diseases.
Other features	The insect exists universally, which makes it difficult to reduce populations in soil.
Control	Use of resistant varieties, crop rotation, compost application, solarization, antagonistic plants, etc.

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Field crickets
[*Gryllus* spp.]

Hypocotyl cut by field crickets

Host plants	Tomatoes, eggplants, green peppers, watermelons, etc.
Damage	**Feeds** or **cuts off** sprouts or young plants
Other features	Hides in hidden tunnels and also damages plant roots.
Control	Spray insecticides on the nursery bed as a repellent. Mancozeb fungicide has repellent effects. Protect the nursery bed with an insect net or boxed frame of more than 20 cm in height

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Aphids
[*Aphis* spp., *Aulacorthum* spp., *Myzuss* spp.]

Colony on the back of a watermelon leaf

Lady bugs are a major natural enemy. Adult (left) and Larva (right)

Host plants	Green peppers, eggplants, watermelons, cabbages, etc.
Damages	**Sucks sap** from plant tissue. Leaves are stunted, distorted, and often curled under. Surfaces become sticky and tainted with black mold. Aphids also transmit CMV, WMV, and other **viral diseases**.
Other features	Has a **symbiotic relationship with ants.** Aphids should be suspected once ants are found on plants.
Control	Spray insecticides with rotation. Banker plants cultivate natural enemies.

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Flea beetles
[*Aulacophora* spp.]

The adults feed on leaves.

Damages on leaves of watermelon (left), okra (center), and cabbage (right)

Host plants	Cucurbit vegetables, okras, etc.
Damage	**Adults feed on leaves** and make 'shot-holes.' **Young seedlings suffer serious damage.** The damage from **larvae feeding on roots** is even more serious.
Other features	Insects of the small leaf beetle family (Chrysomelidae) are generically called "flea beetles." **Epidemic under dry conditions.**
Control	Spray systemic insecticide at 5- to 7-day intervals before the adults lay eggs. The application of granular insecticide in soil effectively controls larvae.

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Fruit flies (Melon flies) [*Bactrocera* spp.]

The adults stay in the backs of the leaves in midday.

Damaged fruit

Larva inside the fruit

Young fruit are covered with paper bags to shield them from infection. The bags will tear as the fruit grows.

A pheromone trap set in the field

Host plants	Cucurbit vegetables, mangoes, tomatoes, etc.
Damages	The adults deposit eggs inside the fruit. The infested fruit rots due to **larvae feeding inside.**
Other features	The adults are active in the morning and evening but stay under the leaves in midday.
Control	Spray systemic insecticides on weeds around the field because the adults stay on the backs of the leaves at midday. Cover the young fruits with paper bags to protect them from infection (because the females prefer to deposit eggs in soft immature fruits). Pheromone traps are set every 10 m.

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Leaf minors
[*Liriomyza* spp.]

Host plants	A wide range of plants
Damages	The adult maggots suck sap from the leaves, leaving tiny white spots on the leaf surfaces. The larvae injure the tissue as they travel across the leaves, leaving white streaky feed damage marks. In severe cases the leaves turn white, then brown, and fall off, suppressing the growth of the plant.
Other features	Many natural enemies exist in the field. Parasitized larvae turn brown.
Control	Spray systemic insecticides a few times at 7-day intervals.

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Insect Pests
Cabbages

Aphids

Diamondback moth

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Cluster caterpillars

White Grubs

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Aphids
[*Lipahis* spp. *Myzus* spp.]

Colony of *Lipahis sp.* on the backs of cabbage leaves

Lady bugs are a major natural enemy. Adult (left) and Larva (right)

Host plants	*Lipahis* spp. infests only plants. *Myzus* spp. *Cruciferou* spp. infest a wide range host plants.
Damages	**Sucks sap** from plant tissue. If the plants are severely infested, masses of aphids will cover them. Infestation soils the leaves and eventually yellows them with decay. Aphids also **transmit CMV** and other viral diseases.
Other features	The insects infest the **backs of the outer leaves** and congregate into colonies. They prefer mild temperatures and dry conditions. Symbiotic relationship with ants.
Control	Spray insecticide carefully on the backs of the leaves. There are many natural enemies.

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Diamondback moth
[*Plutella xylostella*]

Damaged leaves

Damaged leaves and larvae

Pupa on cabbage leaf

An adult moth

Pupa of parasitic wasp and dead larva

A ground spider feeding on a larva

Host plants	Only cruciferous plants
Damage	The larvae feed on leaves. If a population is high, they seriously damage leaves and disrupt head formation. The damage on the head deteriorates quality.
Other features	The larvae die when barraged with raindrops. Thus, **the population increases under less rainy conditions.**
Control	**Insecticide rotation is essential**, as the insects easily acquire resistance. Ground spiders and parasitic or predatory wasps are natural enemies.

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Cabbage webworms [*Hellula* spp.]

Leaves bundled by larvae

Damage on the surface of a cotyledon

Larva bundled in a leaf

Host plants	Only cruciferous plants
Damages	Larvae feed on the surfaces of the leaves or **on the growing point within leaves bundled** by larvae. The young plants with damage on the growing points wilt and die or fail to form heads because few laterals are developed. If a plant grows to middle size, the larvae feed in the petiole.
Other features	Infestation increases under hot and dry conditions.
Control	To avoid serious damage on seedlings, **spray systemic insecticides twice at 7-day intervals in the nursery after germination.**

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Armyworms
[*Spodoptera* spp.]

A leaf riddled with small holes from the feeding of a larvae group

An egg-mass covered with hairs

Matured larva

Severe damage

Ground spiders feed on young larvae.

Host plants	Many crops, including vegetables and weeds.
Damages	Leaves bitten by the young larvae are riddled with small holes. The mature larvae feed extensively on leaves and stems. Young seedlings are cut down.
Other features	Egg-masses covered with hairs are deposited on the backs of the leaves. The hatched larvae feed on leaves in groups and gradually disperse to surrounding plants.
Control	Insecticide control is effective for young larvae but not for matured ones.

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Cluster caterpillars [*Crocidolomia* spp.]

Larvae feed on leaves in groups, often producing threads and hiding under them.

An egg-mass laid on the back of a leaf

Larvae feed on the back surfaces. Damaged leaves become net-like.

Host plants	Cruciferous and some cucurbit plants
Damages	The larvae feed on the back surfaces of leaves in groups. Damaged leaves become netted because the larvae leave the veins intact when feeding.
Other features	Eggs are laid on the backs of leaves in clusters. The larvae produce little threads.
Control	Spray insecticides carefully on the backs of the leaves.

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White grubs
[*Phyllophaga* spp. and others]

Damaged cabbage plants show stunt or wilting

Larvae can be found in the soil near the damaged plants.

The larva is white with a C-shaped body, brown head, and three pairs of legs.

Host plants	Wide hosts, including vegetables, turf, trees and so on.
Damages	**The grubs feed on roots** of many plants. Damaged plants show stunted growth, wilting, and/or yellowing and in some cases die. Vegetable seedlings are often cut down.
Other features	The larvae of certain beetles are generically called “white grubs.”
Control	Upon finding larvae in the soil near cut down plants, apply granular insecticide or pour insecticide dilution.

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White grubs

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Field crickets
[*Gryllus* spp.]

Field cricket nymph

Host plants	Tomato, eggplants, green pepper, watermelon, etc.
Damage	**Feeds** or **cuts off** sprouts or young plants.
Other features	The insects hide in hidden tunnels and also damage the plant roots.
Control	Spray insecticides on the nursery bed as a repellent. Mancozeb fungicide has repellent effects. Protect the nursery bed with an insect net or boxed frame of more than 20 cm in height.

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Thrips
[*Thrips* spp.]

A splashed pattern or white dots appear on the leaf surfaces.

Host plants	Eggplants, green peppers, onions, watermelons, cabbages, tomatoes, etc.
Damage	The damage varies with host plants and species. Generally, a **splashed pattern or white dots** appear on the surfaces of the leaves and bulbs.
Other features	The insect populations increase under conditions with high temperatures and light rain.
Control	Spray insecticides a few times at 7- to 10-day intervals. Light reflection can paralyze the insect.

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Armyworms
[*Spodoptera* spp.]

Leaves damaged by larvae

Larvae feed on the leaves and penetrate inside.

Host plants	Many crops, including vegetables and weeds.
Damages	The larvae feed on the leaves and penetrate inside. Young seedlings are cut down.
Other features	The eggs are laid in masses. The thatched larvae feed on leaves in groups and **gradually disperse to surrounding plants.**
Control	Insecticide control is effective for young larvae but not for matured ones. **Check the insides of the leaves when damaged leaves are discovered.**

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Leak moths
[*Acrolepiopsis* spp.]

The larvae feed their way into the insides of the plants. Whitish traces from feeding remain on the surfaces of the damaged leaves.

Host plants	Allium plants
Damages	**The larvae feed their way into the insides of the plant.** Whitish traces from feeding remain on the surfaces of the damaged leaves.
Other features	Eggs are deposited on the leaves individually. Once hatched, the larvae feed on the leaf surfaces. The second instar larvae feed inside.
Control	Spray systemic insecticides.

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White grubs
[*Phyllophaga* spp. and others]

The larva is white with a C-shaped body, brown head, and three pairs of legs.

Seedlings are cut at the bottom sheath. Larvae may be found in the soil near the damaged plants.

Host plants	A wide range of hosts, including vegetables, turf, trees, and so on.
Damages	**The grubs feed on the roots** of many plants. Damaged plants show stunted growth or yellowing or may even die. Vegetable seedlings are often cut down.
Other features	The larvae of certain beetles are generically called “white grubs.”
Control	Upon finding larvae in the soil near cut down plants, apply granular insecticide or pour insecticide dilution.

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Diseases and Physiological Disorders
Tomatoes

Damping off

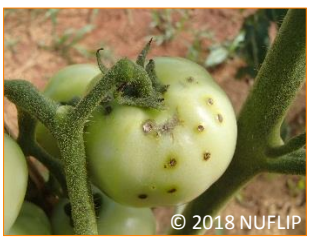
Late blight

Early blight

Fusarium wilt

Southern stem blight

Bacterial canker



Bacterial spot

Bacterial wilt

Mosaic

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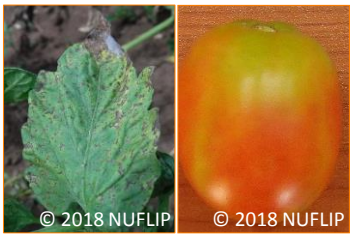
Diseases and Physiological Disorders
Tomatoes

Blossom end rot



Potassium deficiency

Magnesium deficiency

Sunburn

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Damping off
[Fungal disease]

Water-soaked lesions appear at the base of the seedling. The stem softens and cannot support standing.

Pathogen	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia solani*, and other fungi. Diseases that infect seedlings are generically described as “damping-off” diseases.
Host plant	Wide range
Conditions for infection	Seed-borne and soil-borne disease. Although favorable conditions vary based on the pathogen, this disease occurs under **humid conditions.**
Symptoms	**Water-soaked lesions** appear at the base of the seedling. The stem softens and cannot support standing.
Chemical control	Pour preventive fungicides on the nursery bed. Dress the seeds with fungicide or soak the seeds in a fungicide dilution before sowing.
Other measures	Use disease-free soil. Soil disinfection by solarization.

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Late blight
[Fungal disease]

Dark brown and water soaked lesions appear on leaves and stems. White mycelia (conidia) are formed on lesions under humid conditions.

Pathogen	*Phytophthora infestans*
Host plants	**Only** tomatoes and potatoes
Conditions for infection	Seed-borne and soil-borne disease. The pathogen prefers **cool temperature (**around 20°C) and **high moisture.**
Symptoms	**Irregularly shaped brown patches on the leaves**. Lesions on the stems, with dark-brown petioles with a **water-soaked appearance**. White mycelia (conidia) form on the lesions under humid conditions.
Chemical control	Spray mancozeb fungicide when rain is frequent. Use curative fungicides once you find initial symptoms.
Other measures	Using a tolerant variety. Mulching, stalking, and removing excess lower leaves. Maintaining optimum plant density and rotating the crops.

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Early blight
[Fungal disease]

Lesions on the leaf with concentric rings surrounded by yellowing tissue

Pathogen	*Alternaria solani*
Host plants	Tomatoes, eggplants, peppers, etc.
Conditions for infection	Seed-borne and soil-borne disease. The disease develops under **high-temperature** (around 27°C) and **dry conditions**. Spores develop under conditions of high moisture.
Symptoms	Lesions on leaves have **concentric rings** surrounded by yellowing tissue. Dark concentric rings develop on the stem end of the fruit.
Chemical control	Spray mancozeb preventively, then use curative fungicides when initial symptoms appear. Be especially gentle when operating after rains.
Other measures	Using a tolerant variety. Mulching, stalking, and removing excess lower leaves. Maintaining optimum plant density and rotating the crops.

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Fusarium wilt
[Fungal disease]

Leaf yellowing begins at the lower part.

The stem is lignified and with browning vascularity.

Pathogen	*Fusarium oxysporum* f.sp. *lycopersici*
Host plants	**Only tomatoes**
Conditions for infection	Seed-borne and soil-borne disease. The pathogen prefers **high-temperature** (around 27-28^{o}C) and **dry conditions** and **acidic soil (pH5-5.6).**
Symptoms	**Leaf yellowing** begins at the lower part and works upward until the plant eventually dies. **The stem is lignified** and the **vasculature is browning**.
Chemical control	Spray copper fungicide in high-temperature, high-moisture environments.
Other measures	Crop rotation. Use of resistant varieties.

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Southern stem blight [Fungal disease]

Plants wilt and yellow in the field.

A white fungal mat covers the stem near the soil.

Brown tiny spherical sclerotia are found.

Pathogen	*Sclerotium rolfsii*
Host plants	Tomatoes and other solanaceous crops, cabbages, legumes (groundnuts or soybeans), and cucurbits.
Conditions for infection	Soil-borne disease. **High temperature** (around 30°C) and **high soil moisture**
Symptoms	**Plants wilt and yellow in the field**. Brown lesions covered with **a white fungal mat** and **tiny brown spherical sclerotia appear** at the base of the stem.
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	**Crop rotation with cereal crops**. Maintain a dry condition at the base of the stem. Avoid putting immature organic matter into the soil. The infection varies from one variety to another.

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Bacterial canker
[Bacterial disease]

Marginal necrosis on leaves

Necrotic patches on stems

Bird's-eye spots on fruits

Pathogen	*Clavibacter michiganensis*
Host plants	**Tomatoes** (or peppers, nakati)
Conditions for infection	Seed-borne and soil-borne disease. The pathogen prefers **high temperature** (around 25-28^{o}C), **high moisture,** and a **soil pH of 6.9 –7.9.**
Symptoms	**Marginal necrosis** (Firing) on leaves and **necrotic patches** on stems. Small dark spots on the fruit surrounded by a white halo (**bird's-eye spots**). Wilting in the field and browning vasculature are also observed.
Chemical control	Spray copper oxychloride preventively during the seedling stage in the nursery. Bronopol (2-Bromo 2-Nitropropane 1,3 Diol) is preventively effective.
Other measures	Use a resistant/tolerant variety. Crop rotation. Bring infested plants out. The infection can spread during pruning if the pathogen remains on your fingers.

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Bacterial spot
[Bacterial disease]

Tiny, circular, dark lesions on leaves

Elliptical lesions on stems

Brown, slightly sunken, scabby spots

Pathogen	*Xanthomonas campestrispv. vesicatoria*
Host plants	**Tomatoes, peppers, nakati, etc.**
Conditions for infection	Seed-borne and soil-borne disease. The pathogen cannot survive long in the soil without crop debris. The pathogen prefers a temperature of around 24-30^{o}C. It does best at a **nighttime temperature range of 25-28^{o}C and when leaf wetness persists for 24 hrs or more.**
Symptoms	Initial symptoms are **tiny, circular, dark lesions on leaves**. **Immature fruit show brown, slightly sunken, scabby spots**. The lesions on the stems are elliptical in shape.
Chemical control	Spray copper oxchloride if conditions for infection continue. Bronopol (2-Bromo 2-Nitropropane 1,3 Diol) is preventively effective.
Other measures	Use a resistant/tolerant variety. Crop rotation. Bring infested plants out. Eradicate susceptible volunteer plants.

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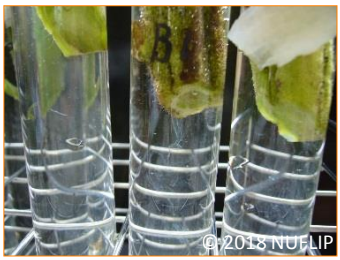
Bacterial wilt
[Bacterial disease]

Plants wilt without yellowing.



Ooze seeps out of the infected plant stem.

Pathogen	*Ralstonia solanacearum* *(= Pseudomonas solanacearum)*
Host plants	**A wide range of hosts. Serious on tomatoes and eggplants.**
Conditions for infection	Soil-borne disease. The pathogen prefers **high temperature** (around 30-35°C) and **high soil moisture**.
Symptoms	**Sudden wilting without yellowing. Bacterial ooze** seeps out from the infected plant stem.
Chemical control	Bronopol (2-Bromo 2-Nitropropane 1,3 Diol) is preventively effective.
Other measures	Use a resistant/tolerant variety. Do not cultivate in lowland fields. Plant on high beds to avoid the excess soil moisture in lowlands. Grass mulching is effective in controlling soil temperature. Apply organic fertilizer or compost to control the pathogen via antagonistic effects.

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Mosaic (Cucumber Mosaic Virus - CMV) [Viral disease]

Severely infested field

Stunted plants with filiform leaves

Mosaic and necrosis on the leaves

Pathogen	Cucumber mosaic virus (CMV)
Host plants	A wide range of hosts. Solanaceous, cucurbit, brassicaceous plants and several kinds of weeds.
Conditions for infection	**Transmitted by aphids** and at low transmission rates in seeds. Local varieties and weeds around the field can be a source of infection. Infection in the nursery causes serious damage.
Symptoms	**Mosaics** on the leaves. F**iliform leaves, necrosis** on the stems and leaves, and necrosis and sun scald on the fruits are observed in some cases. Plants with filiform leaves are stunted with little or no marketable fruit.
Chemical control	Control aphids preventively in and around of the field.
Other measures	No tomato varieties are resistant to CMV. Plant barrier crops such as corns or sorghums to prevent aphids from migrating into the field. Roguing infested plants in and around of the field.

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Blossom end rot
[Physiological disorder]

Symptoms	**Brown water-soaked spots** appear on the end of the fruit.
Causes	Caused by a lack of calcium in the fruit tissues due to shortages of calcium nutrient in the soil or disturbance of translocation by **drought.**
Preventative methods	Apply calcium fertilizer when fruiting and maintain enough soil moisture with irrigation and mulching. Avoid setting excess fruits to prevent competition. Remove damaged or malformed fruits promptly to promote the allocation of more calcium and water for healthy fruits. The severity of infection varies from one variety to another.
Foliar spray	Foliar spray is effective at quickly stopping symptoms as they appear but cannot reverse damages to the fruits.

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Potassium deficiency [Physiological disorder]

Chlorosis remaining the main veins green

Whitish, necrotic dots and tip burn

Fruit with greening on top

Symptoms	Marginal yellow chlorosis develops from the edges of the leaves (**tip burn**). Whitish, **necrotic dots** appear within these chlorotic areas. **The main veins remain green** and the leaves tend to curl and crinkle. The stems become woody and growth is stunted. Flowering and fruiting are compromised. The fruit show a blotchy ripening, with some areas **remaining green near the stalks**.
Causes	This deficiency is common since tomatoes require potassium abundantly when developing fruits. This also shows with aging of the plants.
Preventative methods	**Cow dung compost application is recommended** to provide a rich source of potassium. Apply potassium fertilizer complementarily as the fruits develop. Potassium improves the quality of the fruit.
Foliar spray	Foliar spray can restore chlorosis on leaves.

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Magnesium deficiency [Physiological disorder]

Mottled chlorosis develops in the interveinal tissue of older leaves.

Necrotic patches appear in the highly chlorotic tissue.

Symptoms	Mottled **chlorosis** develops in the interveinal tissue of older leaves, often near the margin. The chlorosis progresses to the middle of the leaf, the small veins also become affected, and **necrotic patches then appear** in the highly chlorotic tissue. The growth is impaired and fruit development and yield are compromised.
Causes	This deficiency is common in tomatoes, especially in sandy soils with low water-holding capacity. Since magnesium is antagonistic to potassium, this deficiency tends to occur in potassium-rich soil.
Preventative methods	Apply compost before planting. Mulching can reduce the erosion of magnesium from the soil.
Foliar spray	Foliar spray is effective at supplying magnesium. Continuous spraying through the harvesting period is recommended.

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Sunburn / Sunscald [Physiological disorder]

The damaged part turns light green. The border between the healthy and damaged parts is clearer than that in blossom end rot.

Symptoms	Young fruits or leaves tend to suffer, acquiring a partially tan to **light-green** color. The affected areas later become **dry and sunken with a papery tan to white texture.** The border between the healthy and damaged parts is clearer than that in blossom end rot.
Causes	The plant tissue is damaged when the temperature rises to around 50°C through longtime exposure to direct sunlight. This condition occurs when the leaves are defoliated by insects or disease.
Preventative methods	Maintain sufficient leaf growth to the protect fruits by promoting plant vigor through proper fertilizer, insect, and disease management. Supply enough water.
Foliar spray	Foliar spray is ineffective, since this is not a nutrient disorder.

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Fertilizer burn
[Physiological disorder]

Symptoms and causes

Symptoms vary as follows.

1. If fertilizers are applied too close to the roots, the plant wilts and dies.
2. If fertilizers are applied in hot midday conditions, the margins of the young leaves turn yellow and then necrotic. Eventually the leaves drop off or the plant dies.
3. If developed in the nursery, fertilizer burn causes germination problems.

In either case, it is difficult for the plants to recover from the damage.

Preventative methods

Do not apply fertilizer too close to the plant roots. Do not apply fertilizer under hot midday conditions. Apply fertilizer in the nursery a few days before sowing.

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Pesticide burn [Physiological disorder]
(Pesticide injury, Phytotoxicity of pesticides)

The soft and sensitive growing points or flowers tend to damage easily.

Symptoms	Symptoms vary according to the case and chemicals used. **Leaf margins are burned** because spray drops remain on the edges. The damaged parts become necrotic.
Causes	The damage occurs due to plant tissue damage from high concentrations of pesticides. Soluble fertilizers can also be a cause. Caused by mistakes in adjusting dilution rates when preparing pesticides. **Spraying under hot midday** conditions also causes damage. Depending on the combination of pesticides, damage may occur. Spraying a mixture of **sticker - azoxystrobin on tomatoes, for example, is risky.**
Preventative methods	Read labels well. Measure pesticides with appropriate tools. Avoid spraying in midday. When spraying azoxystrobin on tomatoes, do not mix sticker.

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Diseases and Physiological Disorders
Eggplants

Brown spot

Black rot

Eggplant rust

Southern stem blight

Fusarium wilt

Bacterial wilt

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Brown spot/ Phomopsis fruit rot [Fungal disease]

Brown and concentric lesions appear.

A fruit with a brown, round and zonate sunken lesion

Pathogen	*Phonopsis vexans*
Host plants	Only eggplants
Conditions for infection	Seed-borne and soil-borne disease. The pathogen **particularly prefers high-humidity conditions.** The optimum temperature is around 25-30°C. This disease occurs anytime in the field or market.
Symptoms	**Brown and concentric lesions** appear on the leaves and older lesions collapse. **Brown, round, and zonate sunken lesion are observed on the fruit.** Infested parts produce many small black specks (pycnidia).
Chemical control	Spray preventive fungicide, especially when rain is abundant.
Other measures	Keep good ventilation by properly spacing the plants and removing the lower leaves. Avoid soil splash or allowing the leaves/fruits to touch the ground when stalking and mulching.

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Black rot
[Fungal disease]

The centers of the lesions are pale. The margins are distinct and purplish-black.

Pathogen	*Corynespora melongenae*
Host plants	Only eggplants
Conditions for infection	Soil-borne disease. The pathogen **prefers a temperature of around 25-28°C and high humidity.**
Symptoms	**Round, brown to purplish-black lesions** appear on the leaves, as well as the stems and fruits. **The centers of the lesions change to a pale** color and the **margins become distinct and purplish-black** as the disease develops.
Chemical control	Spray fungicide preventively when moisture and temperature are high.
Other measures	Crop rotation. Maintain good ventilation in the nursery and in the field.

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Eggplant rust
[Fungal disease]

Spots with yellow halos on the leaf surface (left) and orange spore masses on the back of the leaf (right)

Closeup of spore masses

Pathogen	*Puccinia substriata*
Host plants	Eggplants, African eggplants, millets, and sorghums
Conditions for infection	Prefers cool nights (15-20^{o}C) and warm days (25-34^{o}C). Abundant dew on the foliage causes epidemics. Infested plants of **millet or sorghum could be a source of infection.**
Symptoms	In the early stage, small green to **yellow halos and slightly raised spots appear on the leaf surfaces. Reddish to orange spore masses** appear on the undersides of the leaves. In severe cases, spots also appear on the stems.
Chemical control	Sulphur-containing fungicides prevent spore germination and stunt the growth of the rust. Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	Crop rotation. The severity of infection varies from one variety to another. Carefully observe the infection in sorghum or millet fields near the eggplants.

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Southern stem blight
[Fungal disease]

The plants wilt and yellow. The stem is covered with a white fungal mat and brown tiny sclerotia near the soil.

Pathogen	*Sclerotium rolfsii*
Host plants	Tomatoes and other solanaceous crops, cabbages, **legumes (groundnuts or soybeans)**, and cucurbits.
Conditions for infection	Soil-borne disease. The pathogen prefers **high temperature** (around 30°C) and **high soil moisture.**
Symptoms	**Plants wilt and yellow in the field**. Brown lesions covered with **a white fungal mat** and **tiny brown spherical sclerotia appear** at the base of the stem.
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	**Crop rotation with cereal crops**. Maintain a dry condition at the base of the stem. Avoid putting immature organic matter into the soil. Use tolerant varieties.

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Fusarium wilt
[Fungal disease]

The half of the lower leaf yellows

Wilting symptom

The vasculature is discolored

Pathogen	*Fusarium oxysporum*
Host plants	Varies from one sub-species to another
Conditions for infection	Seed-bone and Soil-borne disease. The pathogen prefers **high temperature (**around 28°C) and **high soil moisture.**
Symptoms	**The half of the lower leaf yellows.** The yellowing spreads to the upper part of the leaf. Ultimately, the whole leaf wilts, dies, and falls off. **The vascular tissue** near the soil line becomes **discolored.**
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	Use a tolerant/resistant variety. Crop rotation with cereal crops, brassica vegetables or sunflowers. Plant on high beds to avoid excess soil moisture in lowlands.

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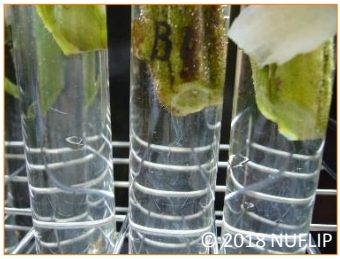
Bacterial wilt
[Bacterial disease]

Plants wilt without yellowing.



Ooze seeps out from the infected plant stem.

Pathogen	*Ralstonia solanacearum* *(= Pseudomonas solanacearum)*
Host plants	**A wide range of hosts. Serious on tomatoes and eggplants.**
Conditions for infection	Soil-borne disease. The pathogen prefers **high temperature** 30-35°C) and **high soil moisture**
Symptoms	**Sudden wilting without yellowing. Bacterial ooze seeps out** from the infected plant stem.
Chemical control	Bronopol (2-Bromo 2-Nitropropane 1,3 Diol) is preventively effective.
Other measures	Use a resistant/tolerant variety. Do not cultivate lowland fields. Plant on high beds to avoid excess soil moisture in the lowlands. Grass mulching reduces increases in soil temperature. Apply organic fertilizer or compost to control the pathogen via the antagonistic effect.

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Diseases and Physiological Disorders
Green Peppers

Damping off

Southern stem blight

Cercospora leaf spot

Corynespora leaf spot / Corynespora blight

Mosaic / Leaf curl

Blossom end rot

Potassium deficiency

Sunburn

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Damping off
[Fungal disease]

Water-soaked lesions appear at the base of the seedling. The stem softens and cannot support standing.

Pathogen	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia solani*, and other fungi. Diseases that infect seedlings are generically described as “damping-off” diseases.
Host plants	Wide range
Conditions for infection	Seed-borne and soil-borne disease. Although favorable conditions vary based on the pathogen, this disease occurs under **humid conditions.**
Symptoms	**Water-soaked lesions** appear at the base of the seedling. The stem softens and cannot support standing.
Chemical control	Pour preventive fungicides on the nursery bed. Dress the seeds with fungicide or soak the seeds in a fungicide dilution before sowing.
Other measures	Use disease-free soil. Soil disinfection by solarization.

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Southern stem blight
[Fungal disease]

A wilting plant

Stem covered with white fungal mat

Tiny sclerotia on the soil near the stem

Pathogen	*Sclerotium rolfsii*
Host plants	Green pepper and other solanaceous crops, legumes (groundnuts or soybeans), and cucurbits.
Conditions for infection	Soil-borne disease. The pathogen prefers **high temperature** (around 30°C) and **high soil moisture**
Symptoms	**Plants wilt suddenly**. Brown lesions covered with **a white fungal mat** and **tiny brown spherical sclerotia appear** at the base of the stem.
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	**Crop rotation with cereal crops**. Maintain a dry condition at the base of the stem. Avoid putting immature organic matter into the soil. Use tolerant varieties.

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Cercospora leaf spot [Fungal disease]

Lesions with light-gray centers and dark-brown margins, aka 'frog-eye.' The lesions do not appear on the fruits.

Pathogen	*Cercospora capsici*
Host plants	Only peppers
Conditions for infection	Soil-borne disease. The pathogen prefers mild temperature (around 20-25^{o}C) and **high-humidity conditions.** The disease tends to occur on lower leaves after the fruits set in conditions where rain is abundant.
Symptoms	Small, circular to oblong chlorotic lesions appear on the leaves, stems, and petiole, **but not on fruits**. The lesions have **light-gray centers and dark-brown margins** (aka 'frog-eye'). In severe cases, numerous spots appear and the leaves turn yellow and defoliate.
Chemical control	Azoxytrobin and Thiophanate methyl are effective.
Other measures	Crop rotation. Mulching to avoid soil splash. Removing infested leaves.

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Corynespora leaf spot / Corynespora blight [Fungal disease]

Lesions with circular or irregular shapes and yellow halos on the margins. The spots appear on both the leaves and fruits.

Pathogen	*Corynespora cassiicola*
Host plants	Solanaceae, cucurbits and etc.
Conditions for infection	Soil-borne disease. The pathogen prefers **mild to high temperatures** (around 20-28°C) and wet conditions.
Symptoms	**Small brown circular spots** initially appear. Later, the spots form into **circular or irregular shapes** with white papery centers delimited by dark brown borders. **Yellow halos often appear around the spots.** Infests **not only leaves but also fruits.**
Chemical control	Spray preventive fungicides, then use curative fungicides when initial symptoms appear. Be especially gentle when operating after rains.
Other measures	Mulching to avoid soil splash. Removing infested leaves or fruits.

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Mosaic / Leaf curl [Viral disease]

Mosaic and leaf curl are typical symptoms of viral diseases. The causal virus is hard to identify, however, by observing the symptoms alone.

Pathogen	Cucumber mosaic virus (CMV) Tobacco mosaic virus (TMV) Pepper mottle virus (PepMoV) Pepper Mild Mottle Virus (PMMoV), etc.
Host plants	A wide range of hosts
Conditions for infection	CMV and PepMov are transmitted by aphids and rarely by seeds. TMV and PMMoV are seed-borne and soil-borne and can also be transmitted by mechanical contact. Local seeds can be a source of infection. Preferable conditions vary with the virus strain.
Symptoms	Symptoms vary with the virus strain and variety of host plant, which makes it difficult to identify a causal virus solely by the symptoms. Typical symptoms of CMV are yellowing with mosaic patterns on the tops leaves. The stems are slightly bent and the plants are stunted. Plants infested with TMV show mosaic patterns with uneven surfaces on the top leaves and malformed fruits with yellow mottles.
Other measures	Use healthy seeds. Control virus vectors with insecticides. Roguing infested plants in and around of the field.

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Blossom end rot
[Physiological disorder]

Symptoms	**Brown water-soaked spots** appear on the end of the fruit.
Causes	Caused by a lack of calcium in the fruit tissues due to shortages of calcium nutrient in the soil or disturbance of translocation by **drought.**
Preventative methods	Apply calcium fertilizer when fruiting and maintain enough soil moisture with irrigation and mulching. Avoid setting excess fruits to prevent competition. Remove damaged or malformed fruits promptly to promote the allocation of more calcium and water for healthy fruits. The severity of infection varies from one variety to another.
Foliar spray	Foliar spray is effective at quickly stopping symptoms as they appear but cannot reverse damages to the fruits.

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Potassium deficiency [Physiological disorder]

Marginal yellow chlorosis appears on the lower leaves and develops from the edges of the leaves (tip burn).

Symptoms	Marginal **yellow chlorosis appears on the lower leaves**. The condition develops from the edges of the leaves (**tip burn**). Whitish, necrotic dots appear within these chlorotic areas. The chlorotic areas turn necrotic and eventually die. Flowering and fruiting are compromised, which decreases the yield.
Causes	This deficiency is common since green peppers require abundant potassium when developing fruits.
Preventative methods	**Cow dung compost application is recommended** to provide a rich source of potassium. Apply potassium fertilizer complementarily as the fruits develop. Potassium improves the quality of the fruit.
Foliar spray	Foliar spray can reduce chlorosis on the leaves but not necrosis.

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Sunburn / Sunscald
[Physiological disorder]

Symptoms	Young fruits or leaves tend to suffer, acquiring a tan to **light-green** color in some areas. Matured fruits tend to redden. The affected areas become **dry and sunken with a papery tan to white texture.** The borders between healthy and damaged parts are clearer than those in blossom end rot.
Causes	The plant tissue is damaged when the temperature rises to around 50°C through prolonged exposure to direct sunlight. This condition occurs when the leaves have been defoliated by insect pests, diseases, or aging.
Preventative methods	Maintain sufficient leaf growth to protect the fruits by promoting plant vigor through proper fertilizer, insect, and disease management. Supply enough water.
Foliar spray	Foliar spray is ineffective, since this is not nutrient disorder.

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Diseases and Physiological Disorders Watermelons

Anthracnose

Alternarial leaf spot

Fusarium wilt

Potassium deficiency

Magnesium deficiency

Fertilization failure

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Anthracnose
[Fungal disease]

Water-soaked lesions or brown-black spots appear on the leaves, stems, and fruits.

Pathogen	*Colletotrichum orbiculare*
Host plants	**Cucurbit vegetables**
Conditions for infection	Seed-borne and soil-borne disease. The pathogen prefers **cool temperature** and **high moisture.**
Symptoms	Small, pale yellow, **water-soaked areas** emerge on old leaves. **Brown or black spots** also appear, usually after vine development. Orange- pink masses of spores develop in the centers of larger leaves. Lesions can form on seedlings, young leaves, petioles, stems, and fruits.
Chemical control	Spray mancozeb fungicide at 7- to 10-day intervals when the vines start developing under warm and rainy conditions.
Other measures	Crop rotation. Using resistant varieties. Removing infested leaves.

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Alternaria leaf spot
[Fungal disease]

Lesions with round to irregular target spots appear on older leaves. As the spots enlarge, concentric rings form in the lesions.

Pathogen	*Alternaria cucumerina*
Host plants	**Cucurbit vegetables**
Conditions for infection	The pathogen may spread from soil or weeds. This disease is favored by warm temperatures and moisture from dew or rain.
Symptoms	Lesions with round to irregular target spots appear on older leaves. As the spots enlarge, **concentric rings** form in the lesions.
Chemical control	Spray mancozeb fungicide at 7- to 10-day intervals when the vines start developing under warm and rainy conditions.
Other measures	Crop rotation. Mulching is recommended.

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Fusarium wilt
[Fungal disease]

Eventually the plant dies. Roots turn pale gray and decay.
Longitudinal cracks appear in the stems.

Pathogen	*Fusarium oxysporum. spp.*
Host plants	The Fusarium group infests many kinds of plants. f.sp. *Nivem* infests watermelon and wax gourd.
Conditions for infection	The pathogen favors warm soil temperatures of around 25–28°C.
Symptoms	At the fruit development stage, the plant weakens and wilts from the lower leaves. **Eventually the plant dies**. Roots turn pale gray and decay. **Longitudinal cracks appear in the stems**. In severe cases, pink mold forms on the cracked surface. The vasculature turns brown.
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	Crop rotation. Use of resistant varieties.

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Potassium deficiency [Physiological disorder]

The margins between veins on the lower leaves turn yellow (chlorosis) and the edges of the leaves then burn (tip burn).

Symptoms	As an initial symptom, the lower leaves form wavy contours around the veins and then curl on the back sides**. The margins between veins on the lower leaves turn yellow (chlorosis) and the edges of the leaves then burn (tip burn).**
Causes	The deficiency occurs in the fruit-setting stage, when the plant requires abundant potassium for fruit development. This, like magnesium deficiency, is common in watermelon cultivation.
Preventative methods	Apply cow dung compost, a rich source of potassium, in advance. Apply additional potassium fertilizer before the fruit develops in size.
Foliar spray	**Foliar spray is recommended** to prevent several types of nutrition deficiency in watermelon production.

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Magnesium deficiency [Physiological disorder]

The margins between veins on lower leaves turn yellow (chlorosis).

Symptoms	**The margins between the veins on lower leaves turn yellow (chlorosis).** Small, dark brown, necrotic patches appear on the highly chlorotic tissue. The fruit quality deteriorates.
Causes	This, like potassium deficiency, is common in watermelon cultivation. The deficiency often occurs often in the fruit-setting stage, when the magnesium requirement increases drastically. Soil drought promotes the deficiency.
Preventative methods	Apply compost before planting to develop a vigorous root system. Be sure not to set an excess number of fruits.
Foliar spray	**Foliar spray is recommended** to prevent several types of nutritional deficiency in watermelon production.

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Fertilization failure [Physiological disorder]

Fruits fall off or turn black after developing to a certain size.

Symptoms	The fruits fall off or turn black after developing to a certain size. The fruit can grow to a certain size even if the female flower is unpollinated, but afterwards it will discolor or fall off.
Causes	Fertilization often fails if poor weather reduces bee activity. High temperature or rain can also weaken the germination vigor of the pollen.
Preventative methods	Be sure to pollinate well to fertilize the plant. Hand pollination is recommended in addition to bee pollination, as bee activity depends on the weather.
Foliar spray	Foliar spray is ineffective.

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Diseases and Physiological Disorders
Cabbages

Alternarial leaf spot / Dark leaf spot

Sclerotium rot

Bacterial soft rot

Bacterial black rot

Mosaic

Flooding damage

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Alternaria leaf spot / Dark leaf spot [Fungal disease]

A.brassicae
Sooty black spores appear on old leaves or the base of the head.

A.brassicola
Circular lesions appear on outer leaves and develop concentric rings.

Pathogen	*Alternaria brassicae, A. brassicola*
Host plants	**Brassica vegetables**
Conditions for infection	Soil-borne and seed-borne disease. *A.brassicae* prefers mild temperatures of around 20-27°C. *A.brassicola* prefers warmer temperatures of around 25-35°C.
Symptoms	The two pathogens show slightly different symptoms. *A.brassicae*: **sooty black spores** appear on old leaves or the base of the head. *A.brassicola*: **circular lesions** appear on the outer leaves and develop concentric rings. Black streaks appear on cotyledons and hypocotyls in the nursery bed.
Chemical control	Spray preventive fungicide.
Other measures	Disease-free seeds. Crop rotation.

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Sclerotium rot
[Fungal disease]

The symptoms are similar to those of bacterial soft rot, but a white fungal mat appears near the soil surface in this disease.

Pathogen	*Sclerotium rolfsii*
Host plants	Tomatoes and other solanaceous crops, legumes (groundnuts or soybeans), and cucurbits.
Conditions for infection	Soil-borne disease. The pathogen is the same as that responsible for southern stem blight on tomatoes. It prefers **high temperature** (around 30^{o}C) and **high soil moisture.**
Symptoms	**Plants** wilt and yellow in the field. Brown lesions covered with **a white fungal mat** and **tiny brown spherical sclerotia appear** at the base of the stem.
Chemical control	Azoxytrobin and Thiophanate methyl are effective at reducing infection.
Other measures	**Crop rotation with cereal crops**. Avoid putting immature organic matter into the soil.

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Bacterial soft rot
[Bacterial disease]

Water-soaked lesions appear and rapidly enlarge. An offensive odor is usually present.

Pathogen	*Erwinia carotovora* subsp. *Carotovora* (*Pectobacterium carotovorum* subsp. *carotovorum*)
Host plants	**Brassica vegetables**
Conditions for infection	Soil-borne disease. Disease development favors warm (25-30°C) and humid conditions.
Symptoms	Small, **water-soaked areas** appear and rapidly enlarge. The tissue becomes soft and mushy, and the affected plant part may collapse within a few days. An offensive **odor** is usually present. The symptoms are similar to those of sclerotium rot but can be easily distinguished by the fungal mat and odor.
Chemical control	Spray copper fungicide under high-temperature, high-moisture conditions.
Other measures	**Insect control is important**. Try to avoid mechanical injury during harvest, packing, and shipping.

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Bacterial black rot
[Bacterial disease]

V-shaped patches of yellowing on the leaf edge

The entire leaf eventually turns yellow or wilts and falls from the plant

Pathogen	*Xanthomonas campestris*
Host plants	**Brassica vegetables**
Conditions for infection	Seed-borne and soil-borne disease. The pathogen prefers **high temperature** (around 30°C) and **high moisture.** It strongly endures drought conditions and can survive for long periods in the soil.
Symptoms	**Yellow V-shaped** patches appear along the leaf edge. Diseased areas turn brown and brittle, then enlarge. **The entire leaf eventually turns yellow** or wilts and falls from the plant
Chemical control	Spray copper fungicide under high-temperature, high-moisture conditions.
Other measures	Crop rotation. Use resistant varieties. Control insect damage, as the pathogen infests from the wounds.

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Mosaic (Cucumber Mosaic Virus - CMV) [Viral disease]

Mosaic on leaves and leaf curling. Necrotic lesions appear between veins or the tips of leaves.

Pathogen	Cucumber mosaic virus (CMV)
Host plants	A wide range of hosts. Solanaceous, cucurbit, brassicaceous plants, and several kinds of weeds.
Conditions for infection	**Transmitted by aphids** and at a low transmission rate in seeds. Weeds around the field can be a source of infection. Infection in the nursery causes serious damage.
Symptoms	Symptoms vary among varieties. They may include **mosaic** on the leaves, yellowing, leaf curling, and pale brown necrosis along the leaf vein. The growth of infested plants is stunted or altogether stopped.
Chemical control	Control aphids preventively in and around the field.
Other measures	No varieties are resistant to CMV. Plant barrier crops such as corns or sorghums to prevent aphids from flying into the field. Roguing infested plants in and around the field.

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Flooding damage
[Physiological disorder]

The lower leaves wilt and the growth is stunted.
The roots rot and the whole plant dies.

Symptoms	The lower leaves wilt and the growth is stunted. The plants take time to recover and their growth is delayed. In severe cases, the roots rot and the whole plant dies.
Causes	As the cabbage roots require abundant oxygen, the hair roots die if they suffer from excess moisture conditions. Plants weakened by flooding stress are easily infested by other soil-borne diseases such as fusarium.
Preventative methods	Do not cultivate cabbage in lowland areas or near swamps in rainy season. Prepare drainage ditches in the field when it rains heavily.
Foliar spray	Foliar spray helps restore plant vigor if the damage is slight but not if it is severe.

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Diseases and Physiological Disorders
Onions

Damping off

Purple blotch

Bacterial soft rot

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Damping off
[Fungal disease]

Water-soaked lesions appear at the base of the seedlings. The stem softens and cannot support standing.

Pathogen	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia solani*, and other fungi. Diseases that infect seedlings are generically described as “damping-off” diseases.
Host plants	Wide range
Conditions for infection	Seed-borne and soil-borne disease. Although favorable conditions for the disease vary by pathogen, this disease occurs under **humid conditions.**
Symptoms	**Water-soaked lesions** appear at the base of the seedlings. The stem softens and cannot support standing.
Chemical control	Pour preventive fungicides on the nursery bed. Dress the seeds with fungicide or soak the seeds in a fungicide dilution before sowing.
Other measures	Use disease-free soil. Soil disinfection by solarization

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Purple blotch / Alternaria leaf spot [Fungal disease]

Lesions are ellipsoidal, 1-3 cm in size, and slightly sunken with pale brown margins.

Pathogen	*Alternaria porri*
Host plants	***Allium* vegetables**
Conditions for infection	Soil-borne disease. The pathogen prefers **high temperature** and **abundant rain**. The disease is not severe at the early growth stage but will spread in later stages if the plants are weakened by unfavorable weather, physical damage, or poor nutrition.
Symptoms	**Lesions are ellipsoidal**, 1-3 cm in size, and slightly sunken with **pale brown margins**.
Chemical control	Spray mancozeb fungicide preventively at the late growth stage, especially if the temperature and moisture are high.
Other measures	Apply compost to boost the plant's vigor.

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Bacterial soft rot
[Bacterial disease]

The leaf sheath turns grayish white to pale brown and softens.

Pathogen	*Erwinia carotovora*
Host plants	***Allium* vegetables**
Conditions for infection	Soil-borne disease. The pathogen survives for long periods in the soil. It prefers **high humidity and temperature** but can grow in a wide range of conditions. The disease is observed **at the bulb-thickening stage. The bulbs decay even after harvest** under high-temperature and high-humidity conditions.
Symptoms	The leaf sheath turns grayish white to pale brown and softens. The decaying bulbs give off **a foul odor.**
Chemical control	Spray copper oxychloride when rain is abundant.
Other measures	Crop rotation. Avoid planting in lowlands. Make high beds to drain the excess water well. Control insects. Dry the harvested bulbs well and remove infested bulbs before storage.

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List of insecticides

- The insecticides listed here only include those found in Gulu town as of October 2018.
- Rotation between insecticides of different classes helps to prevent the insects from acquiring resistance.

Systemic insecticides

Active ingredients transferred into the plant body protect the plant against insect pests.

IRAC MoA Classification	Active ingredients
1A Carbamates	Carbofuran
1B Organophosphates	Acephate Chloropyrifos Dicholorvos Dimethoate Chlorpyrifos Malathion
4A Neonicotinoids	Acetamiprid Imidachloprid Thiamethoxam
6 Avermectins, Milbemycins	Abamectin

Contact insecticides

The effects appear when the insect pests come into direct contact with the insecticide.

IRAC MoA Classification	Active ingredients
3A Pyrethroids, Pyrethrins	Alpha-Cypermethrin Cypermethrin Fenvalerate Lambda-cyhalothrin Tefluthrin

- IRAC – Insecticide Resistance Action Committee
- MoA – Mode of Action
- The classification is based on 'IRAC MoA Classification Version 8.4.'

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List of fungicides

- The fungicides listed here only include those found in Gulu town as of October 2018.

Preventive fungicides

Use preventively before disease occurrence.

FRAC Code	Active ingredients	R. development
M1 Inorganic	Copper oxychloride	Low risk
M2 Inorganic	Sulphur	Low risk
M3 Dithio-carbamates	Mancozeb	Low risk
(None code) Bio fungicides	*Trichoderma viride* *Paecilomyces lilacinus* *Pseudomonus fluoresces*	Resistance not known

Curative Fungicides

Use at the initial stage of disease occurrence.

FRAC Code	Active ingredients	R. development
1 Methyl Benzimidazole Carbamates	Thiophanate methyl Carbendazim	High risk
3 DeMethylation Inhibitors	Hexaconazole	Medium risk
4 Phenyl Amides	Metalaxyl	High risk
11 Quinone outside Inhibitors	Azoxytrobin	High risk
27 Cyanoacetamide-oxime	Cymoxanil	Low – medium

Plant activators

Induce resistance in plants to bacterial diseases

FRAC Code	Active ingredients	R. development
None	Bronopol (2-Bromo 2-Nitropropane 1,3 Diol)	unknown

- FRAC – Fungicide Resistance Action Committee
- FRAC Code – used to distinguish the fungicide groups according to their cross resistance behavior
- The classification is based on 'FRAC Code List ©*2018.'
- R. development – Resistance development

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Explanatory Notes

1. This fact sheet is edited to facilitate the diagnosis of pests, diseases, and physiological disorders in vegetable cultivation fields in Acholi Sub-region of Uganda.

2. The insects, diseases, and physiological disorders described in this fact sheet only include those found in the demonstration fields of Northern Uganda Farmers' Livelihood Improvement Project (NUFLIP) as of October 2018.

3. The detailed descriptions in this sheet were mainly referred the following sources.
   - 'Pests of tropical vegetable crops' published by Japan Association for International Collaboration of Agriculture and Forestry (JAICAF), November 1995.
   - 'Diseases of tropical vegetable crops' published by JAICAF, March 1995.
   - Homepage of the World Vegetable Center https://avrdc.org/
   - 'Disease Guides' Seminis Vegetable Seed Inc. http://www.seminis-us.com/resources/disease-guides/
   - Other published papers

4. Most pictures in this sheet were taken in the NUFLIP demonstration fields. The copyrights are therefore held by the NUFLIP.

5. We would be grateful if users could inform us about any other important insects, diseases, or physiological disorders in Acholi Sub-region not included in this sheet.

October, 2018
All contributors
in the Northern Uganda Farmers'
Livelihood Improvement Project

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